Wind-induced vibrations monitoring with satellite navigation

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Abstract

A Global Navigation Satellite System (GNSS) has been deployed on the Lysefjord Bridge in Norway, to measure the static and dynamic displacement of the deck. One objective is to evaluate the systems capability to monitor accurately wind-induced vibrations in high-latitudes and mountainous terrain. GNSS measurements are compared to displacement records obtained from accelerometers located inside the bridge deck. For data of 10 minutes duration, the accelerometers were observed to monitor frequencies below 0.1 Hz with relatively poor accuracy. The GNSS measurements agreed well with the theoretical estimates of the quasi-static and resonant response of the bridge at low frequencies. The completion of the Galileo system in 2020 should expand the applicability and reliability of such systems for structural monitoring purposes in Northern Europe.

Keywords: GNSS; suspension bridge; wind turbulence; buffeting response; accelerometers; structural health monitoring.

1 Introduction

Accelerometers are widely used to measure the dynamic response of civil engineering structures, although their accuracy at low frequencies is not always adequate [1]. For large structures such as future ultra-long span suspension bridges, the resonant part of the displacement is likely to be located close to or below the operating limit of most accelerometers. During the last two decades, Global Navigation Satellite Systems (GNSS) have been promising tools to monitor the static and quasi-static displacements of civil engineering structures [2, 3]. Until now, the focus has mainly been on the development of methodologies and algorithms to assess the accuracy of GNSS measurement technology [4, 5, 6], as well as on testing its capabilities in comparison to accelerometers [7, 8]. Early applications of GPS technology on suspension bridges started at the end of the 90's [9, 10], and expanded since 2000. In particular, applications to modal parameters identification [7, 8, 11], and to wind-induced vibrations analysis of both suspension bridges [12, 13] and tall-buildings [14, 15] have become increasingly popular. Still there are many uncertainties about the complementary role of GNSS and accelerometers in monitoring wind-induced vibrations of long-span suspension bridges. During the summer of 2015, a GNSS base-rover monitoring system was installed at midspan on the deck of the Lysefjord Bridge in Norway. The

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